

# **SOUTH COAST AIR QUALITY MANAGEMENT DISTRICT**

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## **Draft Staff Report**

### **Proposed Amended Rule 1146.2 - Emissions of Oxides of Nitrogen from Large Water Heaters and Small Boilers and Process Heaters**

**March 2006**

#### **Deputy Executive Officer**

Planning, Rule Development, and Area Sources  
Elaine Chang, DrPH

#### **Assistant Deputy Executive Officer**

Planning, Rule Development, and Area Sources  
Laki Tisopolos, Ph.D., P.E.

#### **Planning and Rules Manager**

Planning, Rule Development, and Area Sources  
Joe Cassmassi

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Author:

Wayne Barcikowski - Air Quality Specialist

Reviewed by:

Gary Quinn, P.E. – Program Supervisor  
William Wong - Senior Deputy District Counsel

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**EXECUTIVE OFFICER:**

BARRY R. WALLERSTEIN, D.Env.

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## **EXECUTIVE SUMMARY**

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## EXECUTIVE SUMMARY

Rule 1146.2 – Emissions of Oxides of Nitrogen from Large Water Heaters and Small Boilers was adopted on January 9, 1998. Rule 1146.2 established nitrogen oxide (NO<sub>x</sub>) emission limits for large water heaters and small boilers with a rating of less than 2 million (MM) Btu/hr. The rule also requires owners of existing units to retrofit with burners that meet the rule emission limits or replace with new units meeting the rule limits. Rule 1146.2 does not regulate residential gas-fired tank type water heaters less than 75,000 Btu/hour heat input which are regulated under AQMD Rule 1121.

Rule 1146.2 was last amended by the AQMD Governing Board at the January 7, 2005 meeting. Under the amended rule, compliance dates for exiting in-use equipment were delayed until a specific unit is 15 years old. The delayed compliance dates for retrofit of existing equipment resulted in fewer emission reductions from 2005 to 2014 compared with the original adopted rule. Lower emissions limits for new equipment were not considered for the January 7, 2005 rule amendment because additional time was needed to evaluate low NO<sub>x</sub> technology and cost effectiveness.

PAR 1146.2 lowers NO<sub>x</sub> emission limits for new equipment and does not impose additional requirements on existing equipment. These lower limits will partially offset emission reductions foregone from the January 7, 2005 rule amendment. In addition, PAR 1146.2 will result in additional NO<sub>x</sub> reductions totaling approximately 1.8 tons/day, reducing ambient levels of ozone, PM10 and PM2.5.

PAR 1146.2 will reduce NO<sub>x</sub> emissions limits for all new manufactured units except for small pool heaters rated less than or equal to 400,000 Btu/hour. Starting January 1, 2010, new manufactured units greater than 400,000 Btu/hour must meet a NO<sub>x</sub> emission limit of 20 ppm. Most new manufactured units less than or equal to 400,000 Btu/hour must meet a 20 ppm (less than 14 ng/Joule heat output) NO<sub>x</sub> limit by January 1, 2012. Pool heaters rated less than or equal to 400,000 Btu/hour, will continue to meet the existing limit of 55 ppm (or 40 ng/Joule heat output).

The cost effectiveness for PAR 1146.2 is estimated to be between \$2,400 and \$16,000 per ton. The cost effectiveness for meeting a 20 ppm NO<sub>x</sub> limit averaged \$2,400 per ton for units greater than 400,000 Btu/hour (Type 2) and up to \$16,000 per ton for Type 1 units less than or equal to 400,000 Btu/hr. The cost difference between meeting the current limits and the 20 ppm limit ranges from zero up to approximately \$3,000 per unit. At rule adoption in January 1998, the cost to meet the current 30 ppm limit was estimated to vary from \$1,500 to \$10,000 per unit.

PAR 1146.2 will also provide more detailed requirements to demonstrate compliance with the 9,000 therm exemption in the rule, clarification of rule applicability, a specific record keeping requirement for larger units and other administrative changes.

## **CHAPTER 1: BACKGROUND**

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**INTRODUCTION**

**REGULATORY HISTORY**

**TYPES OF BOILERS AND HEATERS**

**TECHNOLOGY ASSESSMENT**

**AFFECTED INDUSTRIES**

**PUBLIC PROCESS**

## INTRODUCTION

Rule 1146.2 – Emissions of Oxides of Nitrogen from Large Water Heaters and Small Boilers establishes nitrogen oxide (NO<sub>x</sub>) emission limits for natural gas-fired commercial water heaters and small commercial and industrial boilers and process heaters less than or equal to 2 million (MM) Btu/hour heat input. Commercial/industrial boilers, hot water heaters and process heaters in this size range predominantly burn natural gas to produce steam or heat water and process fluids for a wide variety of applications. Rule 1146.2 does not regulate residential gas-fired tank type water heaters less than 75,000 Btu/hour heat input which are regulated under AQMD Rule 1121.

## REGULATORY HISTORY

Proposed Rule 1146.2 was originally identified as control measure CMB-06 in the 1994 AQMP. The purpose of that measure was to reduce NO<sub>x</sub> emissions without increasing carbon monoxide (CO) emissions from small boilers and process heaters rated less than 2 million Btu/hr. The control measure was carried forward and included in the 1997 AQMP as control measure #97CMB-02B. Rule 1146.2 – Emissions of Oxides of Nitrogen from Large Water Heaters and Small Boilers was adopted on January 9, 1998 and is included in the 1999 Settlement Agreement for the AQMP amendment.

The 1998 adoption of Rule 1146.2 established NO<sub>x</sub> emission limits for large water heaters and small boilers ranging from 75,000 British thermal units per hour (Btu/hr) up to and including 2 million (MM) Btu/hr. Under Rule 1146.2, new water heaters or boilers greater than 0.4 MM Btu/hr and less than or equal to 2 MM Btu/hr (Type 2) were required to meet an emission limit of 30 parts per million (ppm) of NO<sub>x</sub> and 400 ppm of CO. New units from 75,000 Btu/hr to 0.4 MM Btu/hr (Type 1) were required to meet a NO<sub>x</sub> emission limit of 55 ppm or 40 ng/Joule of heat output. Compliance dates for emission limitations were based on the date of equipment manufacture. New Type 2 units were required to meet the emission limit by January 1, 2000 and new Type 1 units were required to meet the emission limit by January 1, 2001. Existing in-use Type 2 units greater than 1 MM Btu/hr and manufactured prior to January 1, 1992 were required to meet the Rule 1146.2 emission limit by January 1, 2002. In-use Type 2 units greater than 1 MM Btu/hr and manufactured between 1992 and 1999 inclusive were required to meet the emission limit by January 1, 2005. Finally, in-use Type 2 units from 0.4 MM Btu/hr and 1 MM Btu/hr were required to meet the rule emission limit by January 1, 2006. In-use units may be modified (retrofitted) or replaced to meet rule requirements.

Rule 1146.2 established a process for certifying new units and retrofit burner kits to comply with emission limits and requires certification tests to be conducted using a District approved protocol. AQMD has developed a certification program (Rule 1146.2 Certification Program) through which manufacturers submit documentation, including source test reports, to AQMD to demonstrate compliance with Rule 1146.2 emission limits.

Units used in recreational vehicles, mobile homes, or RECLAIM facilities are exempt from the requirements of Rule 1146.2. Rule 1146.2 also provides an exemption from the retrofit requirement for units in residences (single family and small apartments) and in-use Type 2 units demonstrated to use less than 9,000 therms of natural gas during each calendar year.

Prior to the January 7, 2005 amendment,<sup>\*</sup> the rule required the AQMD to work with industry and the public, to prepare three implementation studies and report to the AQMD Governing Board 18 months prior to rule compliance dates for new Type 1 units, existing in-use Type 2 units greater than 1 MM Btu/hr, and in-use Type 2 units from 0.4 to 1 MM Btu/hr. All three Rule 1146.2 implementation studies have been completed. A Working Group comprised of manufacturers, end-users, utilities, and other interested parties, provided input and guidance to AQMD staff during each of the implementation studies.

The purpose of the third and final implementation study (Phase III implementation study) was to evaluate the requirements of Rule 1146.2 for retrofit of units greater than 0.4 MM Btu/hr and less than or equal to 1 MM Btu/hr (smaller Type 2 units). Retrofit and/or replacement requirements for the units in this size range were to go in effect for all in-use units January 1, 2006. The findings of the third study were presented at the July 2004 Board meeting. The Phased III study recommended modifying the retrofit requirements and evaluating whether lower NO<sub>x</sub> emission limits were feasible for new equipment.

Based on the findings of the Phase III implementation study, Rule 1146.2 was amended by the AQMD Governing Board at the January 7, 2005 meeting to extend compliance dates for in-use units greater than 400,000 Btu/hour. Under the amended rule, compliance dates for existing in-use equipment were delayed until a specific unit is 15 years old. Lower emissions limits for new equipment were not considered for the January 7, 2005 rule amendment because additional time was needed to evaluate low NO<sub>x</sub> technology and cost effectiveness.

## **TYPES OF BOILERS AND HEATERS**

There are many of types of boilers, water heaters and process heaters subject to AQMD Rule 1146.2. They range from larger boilers that produce high pressure steam to smaller units that are used to provide domestic hot water. There are also a variety of process heaters which either heat process fluids directly or use a heat exchange fluid. For each application there may be several designs of boilers or heaters available. Boilers and heaters can be classified in several ways including the way heat is transferred; the material used in the heat exchanger and the engineering and safety codes the unit is designed to comply with.

A unit is classified as a boiler if it is designed to meet the safety standards of the American Society of Mechanical Engineers (ASME) Boiler and Pressure Vessel Code. While many boilers are used to produce steam, others provide hot water for a variety of purposes. Water heaters are designed to meet safety standards developed by the American National Standards Institute

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<sup>\*</sup> That is, this requirement does not appear in the current version of Rule 1146.2 because it was removed as part of the January 7, 2005 amendment.



(ANSI). The components and the entire system of a boiler or a water heater must meet additional standards including those from Underwriters Laboratories (UL), federal and state energy efficiency standards and local building codes. Some manufacturers produce units that are nearly identical but differ in the safety standards they meet. A buyer can purchase the unit as a hot water boiler meeting ASME standards or as an instantaneous water heater meeting ANSI standards.

## **Boilers**

Historically, boilers have been built using one of three basic designs: fire tube, water tube or cast iron sectional. In a fire tube boiler, the combustion gasses pass through banks of narrow tubes that are surrounded by a pressure vessel (tank) which contains water. The combustion gasses may pass through one set of tubes in one direction (one pass) or make multiple passes by alternating the direction through each set of tubes. Multiple passes of the hot combustion gasses through the pressure vessel increase efficiency and increase the temperature and pressure of the water or steam. This type of boiler can be built using a horizontal pressure vessel and horizontal tubes or a vertical pressure vessel and tubes. Some vertical units are built with a large central tube (combustion chamber) through the pressure vessel and many smaller tubes integral to the outside wall of the vessel. These types of units are often called tubeless, but they work on the same principle as other fire tube boilers.

In a water tube boiler, the combustion gasses pass over and between banks of tubes containing water. Tubes can be made from a variety of metals including copper, steel and other alloys. Increasing the number and surface area of the water tubes will increase the temperature and pressure of water in the tubes and increase the boiler efficiency. Steel water tube boilers can produce very high temperature water or high pressure steam.

Cast boilers pass combustion gasses over the surface of one or more water containing sections made of cast iron. Cast boiler sections can also be made from brass or bronze. This type of boiler can only be used to produce low temperature water or low pressure steam.

A newer type of boiler based on the water tube design uses a heat exchanger made of copper tubes with heat exchange fins. These copper-fin boilers are typically constructed in a factory while older designs may be constructed at the factory or at the location where the unit will be used.

Process heaters are similar to boilers. They may be designed as a fire tube unit that directly heats a process stream or as a water tube unit that heats a specially designed fluid which is then used to heat a process fluid. Process heaters are often operated at very high temperature which makes it more difficult to lower NO<sub>x</sub> emissions.

## Water Heaters

The water heater category includes a wide variety of designs from simple tank type heater with atmospheric or power burners to larger units with sophisticated controls and which are identical in design to hot water boilers. This category also includes direct contact heaters in which water is heated through direct contact with combustion gasses and small gas-fired instantaneous heaters which are based on the water tube boiler design and are similar to residential hot water boilers. Small instantaneous water heaters and hot water boilers can be built as floor standing or wall hung units. All water heaters sold in the United States must meet design and safety requirements developed by ANSI.

## TECHNOLOGY ASSESSMENT

Low NO<sub>x</sub> burners for boilers and heaters in this size range can achieve less than 10 ppm NO<sub>x</sub> (at 3% oxygen). There are a large number of products regulated by this rule that have achieved less than 20 ppm. A summary of Rule 1146.2 certification test results is provided in Table 1.1 and Table 1.2. The current equipment certified pursuant to Rule 1146.2 includes a wide variety of equipment types and burner systems.

The certification results show that manufacturers have made substantial progress in reducing the NO<sub>x</sub> emissions from small boilers and large water heaters. Half of the larger Type 2 units tested under the certification program meet the proposed limit of 20 ppm. Approximately 20 percent of the smaller Type 1 units meet the proposed limit and one third of the boilers and boiler type water heaters in this size range tested meet the proposed limit. Two categories of equipment, tank type water heaters and residential instantaneous water heaters, have a low number of units meeting the proposed limit. Two families of the smaller tank type water heaters and none of the residential instantaneous water heaters tested currently meet the proposed emission limit. These two types of equipment are typically not built using modern low NO<sub>x</sub> burner technology. However, there are small boilers in the same Btu range with NO<sub>x</sub> emissions less than 20 ppm and slightly larger tank type units that meet the proposed limit. In addition, residential tank type water heaters that meet an emission AQMD Rule 1121 limit of 15 ppm will be available in 2007.

<b>Table 1.1 - Certification Test Results For Type 2 Units &gt; 400,000 to 2 mmBtu/hour</b>				
<b>NOX (ppm)</b>	<b>Hot Water Boilers, Pool &amp; Instant Water Heaters</b>	<b>Steam Boiler &amp; Process Heater</b>	<b>Tank Type Water Heater</b>	<b>&gt; 400,000 Total</b>
<b>Tests &lt; 20 ppm</b>	40	11	3	54
<b>Total Tests</b>	79	35	9	123
<b>Percentage meeting 20 ppm</b>	53%	31%	33%	46%
<b>Estimated Number in District</b>	11,000	5,500	5,500	22,000

<b>Table 1.2 - Certification Test Results For Type 1 Units ≤ 400,000 Btu/hour</b>					
<b>NOX (ppm)</b>	<b>Hot Water Boilers &amp; Instant Water Heaters</b>	<b>Steam Boilers &amp; Process Heaters</b>	<b>Residential Instant Water Heaters</b>	<b>Tank Type Water Heater</b>	<b>≤400,000 Total</b>
<b># Tests &gt; 20 – 30 ppm</b>	<b>12</b>	<b>6</b>	<b>0</b>	<b>7</b>	<b>25</b>
<b># Tests ≤ 20 ppm</b>	<b>15</b>	<b>3</b>	<b>0</b>	<b>5</b>	<b>23</b>
<b>Total Tests</b>	<b>50</b>	<b>11</b>	<b>15</b>	<b>50</b>	<b>126</b>
<b>% &lt; 20 ppm</b>	<b>30%</b>	<b>27%</b>		<b>10%</b>	<b>18%</b>
<b>Estimated Number in District</b>	<b>21,800</b>	<b>10,900</b>	<b>Included in Instant W. H.</b>	<b>10,900</b>	<b>43,600</b>

The manufacturers of boilers, water heaters and process heaters use similar approaches to achieve low NO<sub>x</sub> levels. The principle technique involves premixing of fuel and air before combustion takes place. This results in a lower and more uniform flame temperature. A lower flame temperature reduces formation of NO<sub>x</sub>. Some premix burners also use staged combustion with a fuel rich zone to start combustion and stabilize the flame and a fuel lean zone to complete combustion and reduce the peak flame temperature.

Burners can also be designed to spread flames over a larger area to reduce hot spots and lower NO<sub>x</sub> emissions. Radiant premix burners with ceramic, sintered metal or metal fiber heads spread the flame and produce more radiant heat. When a burner produces more radiant heat, it can result in less heat escaping the boiler through exhaust gasses.

Most premix burners require the aid of a blower to mix the fuel with air before combustion takes place (primary air). Increasing the amount of primary air can reduce flame temperature but it also reduces the temperature of combustion gasses through dilution and can reduce heat transfer efficiency. To maintain efficiency, a manufacturer may modify the burner design or use different materials in the burner head to reduce the amount of excess air required. Alternatively they may add surface area to the heat exchanger to maintain efficiency. Increasing primary air may destabilize the flame. Ultra low NO<sub>x</sub> burners require sophisticated controls to maintain emissions levels, efficiency and a stable flame.

There are a variety of manufacturers of boilers, burners, burner materials and control systems that currently manufacture products that achieve a NO<sub>x</sub> emission limit of 20 ppm. Boiler manufacturers have a variety of choices available. However, each manufacturer must design an integrated product. This will require time for redesign of a family of products to meet the proposed limits.

## **AFFECTED INDUSTRIES**

Rule 1146.2 affects manufacturers (SIC 3433), distributors and wholesalers (SIC 5074), as well as owners and operators of large water heaters and small boilers in the district. Based on a survey conducted by the AQMD staff prior to rule adoption, these boilers and water heaters can be found in every sector of the economy. The units are used in apartment and office buildings, and by commercial and industrial operations such as hotels, laundering, restaurants, and a wide variety of manufacturing businesses. At rule adoption, staff estimated that there were over 65,600 units in the District in the size range affected by this rule (75,000 to 2 MM Btu/hr). Staff estimated that about two thirds (43,600) of the units affected by this rule are smaller units rated less than or equal to 0.4 MM Btu/hr. The remainder (22,000) are greater than 0.4 MM Btu/hr (Type 2 units). Staff estimates that 60% of the Type 2 units are greater than 1 MM Btu/hr.

## **PUBLIC PROCESS**

The rule development effort for PAR 1146.2 is part of an ongoing process to assess low NO<sub>x</sub> technologies for boilers and heaters. For this rule development, staff held four working group meetings since March 1, 2005, a public workshop on October 5, 2005 and a public consultation meeting on January 17, 2006. These meetings were attended by representatives from manufacturers, trade organizations and other interested parties. At these meetings low NO<sub>x</sub> technology, Rule 1146.2 certification test results and proposed emission limits were discussed. Staff also held individual meetings with manufacturers of boilers, water heaters, burners and burner materials.

## **CHAPTER 2: SUMMARY OF PROPOSED AMENDED RULE 1146.2**

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**EXISTING RULE REQUIREMENTS**

**PROPOSED AMENDED RULE 1146.2**

## EXISTING RULE REQUIREMENTS

Rule 1146.2 requires new small boilers and large water heaters in the size range of 75,000 Btu/hr to 2 MM Btu/hr to meet a specified NO<sub>x</sub> emission limit based on the date of manufacture. New Type 2 units (greater than 0.4 MM Btu/hr) must meet a 30 ppm emission limit by January 1, 2000. New Type 1 units in the size range of 75,000 Btu/hr to 0.4 MM Btu/hr must meet a NO<sub>x</sub> emission limit of 55 ppm (or 40 ng/Joule) by January 1, 2001.

Existing Type 2 units must meet a 30 ppm NO<sub>x</sub> limit when they are 15 years old starting January 1, 2006. Existing in-use Type 2 units greater than 1 MM Btu/hr manufactured before 1992 were required to be retrofitted or replaced with new units meeting the rule limit by July 1, 2002. Existing in-use Type 1 units are not required to be retrofitted with new low NO<sub>x</sub> burners. In addition, Type 2 units using less than 9,000 therms per year are exempt from the retrofit requirement.

## PROPOSED AMENDED RULE 1146.2

PAR 1146.2 will reduce NO<sub>x</sub> emissions limits for all new manufactured units except for small pool heaters rated less than or equal to 400,000 Btu/hour. Starting January 1, 2010, new manufactured units greater than 400,000 Btu/hour must meet a NO<sub>x</sub> emission limit of 20 ppm or less than 14 ng/Joule of heat output. Most new manufactured units less than or equal to 400,000 Btu/hour must meet a 20 ppm NO<sub>x</sub> limit by January 1, 2012. The exception is pool heaters rated less than or equal to 400,000 Btu/hour which will continue to meet the existing limit of 55 ppm (or 40 ng/Joule heat output). The equipment regulated by the rule and proposed compliance dates are summarized in Table 2.1.

<b>Table 2.1 – PAR 1146.2 Compliance Dates By Equipment Type</b>		
<b>Product Type</b>	<b>Size (x1000 Btu/hour)</b>	<b>Effective Date</b>
<b>Steam &amp; Hot Water Boilers &amp; Process Heaters</b>	< 400	Jan-2012
	> 400 – 2,000	Jan-2010
<b>Instantaneous Water Heaters (Includes floor standing and wall hung water heaters)</b>	< 400	Jan-2012
	> 400 – 2,000	Jan-2010
<b>Tank Type Water Heaters</b>	< 400	Jan-2012
	> 400 – 2,000	Jan-2010

PAR 1146.2 requires a progress report for specific types of equipment in order for AQMD staff to assess whether the proposed emission limits can be met. The proposed rule will also make specific the requirements for demonstrating compliance with the 9,000 therm exemption limit for retrofitting existing in-use equipment. The amendment will specify that compliance must be

demonstrated with an individual gas meter or timer on the gas line providing fuel to the boiler. The proposed amendment will also remove requirements which are no longer applicable and clarify rule applicability. PAR 1146.2 will require owners to install a new permanent rating plate when a burner is modified or changed. In addition, PAR 1146.2 requires owners and operators to maintain equipment according to manufacturer's specifications and retain records of routine maintenance activities for at least three years.

## **CHAPTER 3: IMPACT ASSESSMENT**

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**IMPACT ANALYSIS**

**COST EFFECTIVENESS**

**INCREMENTAL COST-EFFECTIVENESS**

**CALIFORNIA ENVIRONMENTAL QUALITY ACT (CEQA) ANALYSIS**

**SOCIOECONOMIC ASSESSMENT**

**DRAFT FINDINGS UNDER CALIFORNIA HEALTH & SAFETY CODE  
SECTION 40727**

**COMPARATIVE ANALYSIS**



## IMPACT ANALYSIS

Staff has prepared a preliminary analysis of the impacts of PAR 1146.2. The proposed rule is estimated to reduce NO<sub>x</sub> emissions by a total of 1.8 ton per day by 2026. A summary of the emission reductions by milestone year is provided in Table 3.1. Emission reductions were calculated using the difference between the emission factor for the existing emission limit and the proposed limit. This difference is multiplied by the average rating in the size category, the number of units in the category and a capacity factor (usage factor) of 21.5%. (The 21.5% capacity factor was based upon a survey conducted for the initial rule adoption and confirmed by data reported in a 2004 Southern California Gas boiler study.). PAR 1146.2 results in a reduction in NO<sub>x</sub> emissions of approximately 0.1 ton per day each year starting in 2012 and a total reduction of 1.8 ton per day.

<b>Table 3.1 - NO<sub>x</sub> Emission Reductions By Year For Proposed Rule 1146.2</b>			
	<b>Boiler/Heater Category</b>		
<b>Year</b>	<b>≤ 400,000 Btu/hr</b>	<b>&gt; 400,000 Btu/hr</b>	<b>Total</b>
	<b>(Ton/Day)</b>		
<b>2010</b>		0.04	0.04
<b>2012</b>	0.08	0.12	0.2
<b>2020</b>	0.72	0.44	1.16
<b>2026</b>	1.2	0.6	1.8

## COST EFFECTIVENESS

The cost for most new low NO<sub>x</sub> units achieving the proposed limits was estimated from data provided by manufacturers and vendors of boilers, heaters and burners in the size range affected by Rule 1146.2. For low input (< 100,000 Btu/hour) tank type water heaters, staff used the cost effectiveness information from the November 1999 staff report for amendment of Rule 1121 – Control of Nitrogen Oxides From Residential Type Natural Gas-Fired Water Heaters. With the exception of these low heat input tank type water heaters, the cost effectiveness is based on a useful life of 15 years. The cost effectiveness for the low heat input tank type water heaters is based on a 10 year useful life and the Rule 1121 staff report.

From the survey, the cost effectiveness for meeting a 20 ppm NO<sub>x</sub> limit averaged \$2,400 per ton for units greater than 400,000 Btu/hour (Type 2) and up to \$16,000 per ton for Type 1 units less than or equal to 400,000 Btu/hr. The average per unit cost difference between meeting the current Btu/hour specified limit and the 20 ppm limit ranges from zero up to about \$3,000. At rule adoption in January 1998, the average per unit cost to meet the current 30 ppm limit was estimated to be \$1,500 to \$10,000. (The cost effectiveness for each category of equipment is calculated as the difference in average cost to meet a specific limit divided by additional tons of NO<sub>x</sub> reduced. For example: for a 2,000,000 Btu/hour rating, the average cost to attain the 30 ppm limit is \$22,222. The cost increases to \$23,167 if the limit is lowered to 20 ppm. The

difference in cost to move to the lower emissions limit is \$945 [\$23,167 -\$22,222]. This difference is then divided by the expected additional NO<sub>x</sub> emissions reduction, 0.30 tons, to obtain an approximate cost effectiveness of \$3,100 for this category of units.)

**Type-1 Units < 100,000 Btu/Hour**

Based on the Rule 1121 staff report, the cost effectiveness for smaller tank type water heaters (< 100,000 Btu/hour) to achieve a 20 ppm limit is \$4,000 to \$16,000 per ton.

**Type-1 Small Pool Heaters <400,000 Btu/Hour**

The cost effectiveness for small pool heaters less than 400,000 Btu/hour to meet a 20 ppm NO<sub>x</sub> limit is much greater than \$20,000 per ton. The cost effectiveness is high for pool heaters because of the small number of hours these units operate each year. Based on the cost effectiveness and the limited operation time, staff has proposed the NO<sub>x</sub> emission limit for small pool heaters remain at 55 ppm.

**Type 1 Units > 100,000 and < 300,000 Btu/hour**

Table 3.2 summarizes the cost effectiveness for Type 1 Units > 100,000 and < 300,000 Btu/hour meeting the 20 ppm NO<sub>x</sub> emissions limit from the current limit of 55 ppm. Of the five manufacturers of commercial tank type water heaters certified by the AQMD, two manufacturers have lines of equipment with test results below the proposed 20 ppm limit. One manufacturer produces a line of standard efficiency low NO<sub>x</sub> units tested at below 20 ppm and a different manufacturer produces a line of high efficiency units tested at below 20 ppm. A third manufacturer produces standard efficiency units with emissions below 30 ppm. According to local distributors and installers, the cost of similar units does not vary between manufacturers. High efficiency units cost more than standard units and a unit with ASME tank certification costs more than a standard unit, but there is no significant difference in cost between similar units meeting the current standard and those meeting 20 ppm.

Based on the cost of small residential boilers and tank type units, staff estimates that the purchase cost for small residential instantaneous water heaters ("tankless" water heaters) to meet the 20 ppm limit would be less than \$1,000 per unit and the cost effectiveness would be less than \$10,000 per ton. It is not possible to estimate the exact cost increase at this time. The small residential boiler/water heaters that meet 20 ppm or 30 ppm are high efficiency units (>95%) and they include many more features than the standard units which cost about \$1,000 less. These high efficiency units include finer control (modulation) of the firing rate of the burner, more sophisticated computer control systems to regulate the distribution of heat between radiant heating zones and hot water supply and require a more expensive heat exchanger and exhaust system because they are condensing units. Most residential boilers are also certified to ASME standards. All of these features add cost and are included in the \$1,000 cost difference. Many residential instantaneous water heaters (tankless units) do have sophisticated controls for the burner system. However, most of them are not high efficiency units and the control systems are less costly. For these reasons residential instantaneous water heaters cost less than residential boilers with a similar rating.

<b>Table 3.2 - Cost Effectiveness for Type 1 Units &gt; 100,000 and &lt; 300,000 Btu/hour</b>				
<b>Equipment Type</b>	<b>Cost <sup>1</sup> and Emission Reductions</b>	<b>Emission Level (ppm)</b>		
		<b>55</b>	<b>30</b>	<b>20 <sup>2</sup></b>
<b>Commercial Tank Type Standard Efficiency</b>	Cost per Unit	\$2,300 - \$3,300	\$2,300 - \$3,300	\$2,300 - \$3,300
	Number of Manufacturers	3 of 5	1 of 5	1 of 5
	Additional Tons NOx reduced		0.08	0.1
	Cost Effectiveness (\$/ton)		\$0	\$0
<b>Commercial Tank Type High Efficiency</b>	Cost per Unit	\$3,600 - \$4,500		\$3,600 - \$4,500
	Number of Manufacturers	4 of 5		1 of 5
	Additional Tons NOx reduced			0.1
	Cost Effectiveness (\$/ton)			\$0 <sup>3</sup>
<b>Residential Boilers/Water Heaters</b>	Cost per Unit	\$2,800 - \$3,100	\$3,800 - \$4,300	\$3,800 - \$4,000 <sup>4</sup>
	Number of Units	2	2 <sup>5</sup>	3 <sup>5</sup>
	Additional Tons NOx reduced		0.08	0.1
	Cost Effectiveness (\$/ton)		\$12,500	\$10,000

<sup>1</sup> Cost varies by size, features and source. The cost for tank type units is based on 100 to 120 gallon tank size without ASME certification. The cost for residential boilers/heaters is based on units rated less than 200,000 Btu/hr. ASME certification increases the cost of a tank type water heater by \$1,000 to \$1,500. Residential boiler/heater cost includes ASME certification. According to local distributors and installers, the California market is very competitive and the cost of tank type water heaters is significantly lower than for other regions of the country.

<sup>2</sup> Proposed concentration limit.

<sup>3</sup> The cost between a high efficiency tank type unit meeting 20 ppm and a standard efficiency unit meeting 55 ppm is about \$1,300. For this comparison, the NOx cost effectiveness ranges from \$11,000 to \$14,500 per ton depending upon rating of the unit.

<sup>4</sup> Cost for a line of boilers/water heaters from one manufacturer not yet certified by AQMD. Manufacturer states that NOx emission are less than 20 ppm.

<sup>5</sup> High efficiency units

### **Type 1 Units From 300,000 to 400,000 Btu/hour**

Table 3.3 summarizes the cost effectiveness for Type 1 Units > 300,000 and < 400,000 Btu/hour meeting the 20 ppm NOx emissions limit from the current limit of 55 ppm. Type 1 units from 300,000 to 400,000 Btu/hr are often based on the same design as Type 2 units greater than 400,000 Btu/hr. Local building codes may also require some units greater than 200,000 Btu/hr to meet ASME certification which increases cost. The equipment cost for units in the 300,000 to 400,000 Btu/hr range with certification tests below 20 ppm or 30 ppm is less than but consistent with the cost of Type 2 units meeting these emission levels. The cost effectiveness for the proposed 20 ppm limit for this category of equipment is estimated to be \$16,000 per ton.

<b>Table 3.3 - Cost Effectiveness for Type 1 Units From 300,000 to 400,000 Btu/hour</b>					
<b>Rating (BTU/hr)</b>	<b>Cost and Emission Reductions</b>	<b>Emission Level (ppm)</b>			
		<b>55</b>	<b>30</b>	<b>20 <sup>1</sup></b>	<b>12</b>
<b>300,000 – 400,000</b>	Average Cost per Unit	\$5,134	\$8,340	\$8,400	\$12,900
	Number of Units	5	10	7	3
	Additional Tons NOx reduced		0.15	0.2	0.25
	Cost Effectiveness (\$/ton)		\$21,700	\$16,100	\$31,500

<sup>1</sup> Proposed concentration limit.

### Type 2 Units More than 400,000 Btu/hour

Table 3.4 summarizes the cost effectiveness for Type 1 Units > 300,000 and < 400,000 Btu/hour meeting the 20 ppm NO<sub>x</sub> emissions limit from the current limit of 55 ppm. From the survey, the cost effectiveness for meeting a 20 ppm NO<sub>x</sub> limit averaged \$2,400 per ton for units greater than 400,000 Btu/hour. The average cost effectiveness is based on the survey which grouped units into four categories: 400,000 - 500,000, 1,000,000, 1,500,000, and 2,000,000 Btu/hour. Within the > 400,000 Btu/hour rating the cost effectiveness ranged from \$0 to \$3,400 with units in the 400,000 – 500,000 Btu/hour category showing an average reduction in cost when meeting the lower emission limit of 20 ppm.

<b>Table 3.4 - Cost Effectiveness for Type 2 Units More than 400,000 Btu/hour</b>				
		<b>Emission Level (ppm)</b>		
<b>Rating (BTU/hr)</b>	<b>Cost and Emission Reductions</b>	<b>30</b>	<b>20 <sup>1</sup></b>	<b>12</b>
<b>2,000,000</b>	Average Cost per Unit	\$22,222	\$23,167	\$32,274
	Number of Units	14	12	12
	Additional Tons NO <sub>x</sub> reduced		0.30	0.57
	Cost Effectiveness (\$/ton)		\$3,100	\$17,600
<b>1,500,000</b>	Average Cost per Unit	\$19,571	\$20,381	\$27,729
	Number of Units	11	7	9
	Additional Tons NO <sub>x</sub> reduced		0.23	44
	Cost Effectiveness (\$/ton)		\$3,400	\$18,900
<b>1,000,000</b>	Average Cost per Unit	\$14,440	\$14,614	\$22,115
	Number of Units	14	11	10
	Additional Tons NO <sub>x</sub> reduced		0.16	0.29
	Cost Effectiveness (\$/ton)		\$1,100	\$26,400
<b>400,000 - 500,000</b>	Average Cost per Unit	\$10,012	\$9,393	\$12,726
	Number of Units	16	12	5
	Additional Tons NO <sub>x</sub> reduced		0.08	0.14
	Cost Effectiveness (\$/ton)		\$0	\$18,700
<b>Average Cost for All Units</b>		\$15,980	\$16,436	\$25,601
<b>Number of Units</b>		58	43	36
<b>Average Tons NO<sub>x</sub> Reduced</b>			0.19	0.40
<b>Average Cost Effectiveness (\$/ton)</b>			<b>\$2,400</b>	<b>\$24,100</b>

<sup>1</sup> Proposed concentration limit.

## INCREMENTAL COST-EFFECTIVENESS

Health and Safety Code Section 40920.6 requires an incremental cost-effectiveness analysis for Best Available Retrofit Control Technology (BARCT) rules or emission reduction strategies when there is more than one control option which would achieve the emission reduction objective of the proposed amendments, relative to ozone, CO, SO<sub>x</sub>, NO<sub>x</sub>, and their precursors.

As the proposal to amend Rule 1146.2 does require additional emission controls or emission reduction strategies for new equipment, to fulfill the incremental cost effectiveness analysis

requirement of the Health and Safety code, staff has considered the option of requiring a lower NO<sub>x</sub> emission standard for Type 1 and Type 2 units.

A NO<sub>x</sub> emission standard less than 20 ppm for smaller Type 1 units is not feasible at this time. However, manufacturers have proposed a higher limit of 30 ppm for these smaller Type 1 units. The technology that is currently used in larger units to meet a 30 ppm limit is the same technology used to meet a 20 ppm limit. For this reason, there is no difference in cost between the 20 ppm and 30 ppm emission levels and therefore the incremental cost effectiveness is zero. The cost effectiveness for smaller Type 1 units to meet a 30 ppm limit is also higher than for a 20 ppm limit because the equipment cost is the same and the emission reductions are less.

Type 2 units are capable of meeting a lower emission level. Staff evaluated the cost effectiveness for larger Type 2 units to meet a lower NO<sub>x</sub> emission limit of 12 ppm. This is the current BACT limit for Rule 1146.1 units at minor sources. However, the cost effectiveness between 30 ppm and 12 ppm is greater than for 20 ppm (see Table 3.2). The incremental cost effectiveness between NO<sub>x</sub> emission limits of 30 ppm and 12 ppm is about \$43,600 per additional ton reduced (  $(\$25,601 - \$16,436) \div 0.21 \text{ ton} \approx \$43,600/\text{ton}$  )

## CALIFORNIA ENVIRONMENTAL QUALITY ACT (CEQA) ANALYSIS

Pursuant to the California Environmental Quality Act (CEQA) and AQMD Rule 110, the appropriate CEQA documentation will be prepared to analyze any potential adverse environmental impacts associated with PAR 1146.2. Upon completion, the CEQA document will be released for public review and comment, and will be available at AQMD Headquarters, by calling the AQMD Public Information Center at (909) 396-3600, or by accessing AQMD's CEQA website at: [www.aqmd.gov/ceqa](http://www.aqmd.gov/ceqa).

## SOCIOECONOMIC ASSESSMENT

### Socioeconomic Impacts

The proposed amendments will lower NO<sub>x</sub> limits on newly manufactured heaters and boilers beginning in 2010. Because of confidentiality, additional research and development (R & D) costs necessary to meet the lower limits are unknown from manufacturers. Based on the price differential between compliant and noncompliant units currently, the price of a compliant unit less than or equal to 400,000 Btu per hour (Type 1) is estimated to rise by \$2,300, on average, based on the midpoint of low- and high-end estimates. The price of a compliant unit more than 400,000 Btu per hour (Type 2) is to increase by \$450, on average.

Presently there are approximately 43,600 units of Type 1 and 22,000 units of Type 2, respectively. Under the assumption of 15 years of useful life per unit, on average, 2,180 units of Type 1 and 1,100 units of Type 2 would be replaced annually with compliant units. Eighteen percent of tested new Type 1 units and 46 percent of Type 2 units already currently meet the proposed NO<sub>x</sub> standards. As such, no additional compliance cost is expected of these units. Based on this information, it was conservatively assumed that 75 percent of the future

replacement units would be sold at higher prices as manufacturers of these units implement lower NOx limits and pass the additional R & D cost to their consumers.

The proposed amendments also require that manufacturers of Type 1 units and Type 2 fire tube boilers and thermal fluid heaters submit progress reports on burner and control technologies and their emission tests to the District in 2008 and 2010, respectively. It was assumed that the cost of preparing a progress report by a manufacturer is \$5,000 based on 50 hours at \$100 per person hour. There are approximately 50 Type 1 and 20 Type 2 manufacturers in the U.S. and nine of them in each category are located in the District.

### Cost Impact

The cost of the proposed amendments include the cost of replacing existing Type 1 and Type 2 units with compliant units and the cost of filing progress reports. The average annual cost of the proposed amendments is projected to be \$1.82 million from 2008 to 2020, assuming that the units have an economic life of 15 years. The replacement cost (\$1.64 million) will be born by almost every sector in the economy. Homeowners in multi-unit dwellings will be affected as well.

### Small Business Impact

The AQMD defines a "small business" in Rule 102 as one which employs 10 or fewer persons and which earns less than \$500,000 in gross annual receipts. In addition to the AQMD's definition of a small business, the federal Small Business Administration (SBA), the federal Clean Air Act Amendments (CAAA) of 1990, and the California Department of Health Services (DHS) also provide definitions of a small business.

The SBA's definition of a small business uses the criterion of gross annual receipts (ranging from \$0.5 million to \$25 million), number of employees (ranging from 100 to 1,500), or assets (\$100 million), depending on industry type. The SBA definitions of small businesses vary by 6-digit NAICS code.<sup>1</sup> The cutoff for the manufacturers of heating equipment (NAICS 333414) is 500 employees.<sup>2</sup> The cutoff for wholesalers of boilers and heaters (NAICS 423720) is 100 employees.<sup>3</sup> Finally, the cutoff for the lessors of residential buildings and dwellings industry (NAICS 531110) is \$6 million and that for the residential property managers industry (NAICS 531311) is \$1.5 million.<sup>4</sup>

The CAAA classifies a facility as a "small business stationary source" if it: (1) employs 100 or fewer employees, (2) does not emit more than 10 tons per year of either VOC or NOx, and (3) is a small business as defined by SBA.

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<sup>1</sup> NAICS stands for the North America Industrial Classification System.

<sup>2</sup> Small Business Administration, Table of Small Business Size Standards, Washington, D.C. 2004, Retrieved from <http://www.sba.gov/size/sizetable2002.pdf>.

<sup>3</sup> Ibid.

<sup>4</sup> Ibid.

The DHS definition of a small business uses an annual gross receipt criterion (ranging from \$1 million to \$9.5 million, depending on industry type) for non-manufacturing industries and an employment criterion of fewer than 250 employees for manufacturing industries.

No published information on employment and sales of the nine local manufacturers of boilers and heaters can be found. The majority of wholesalers of boilers and heaters, lessors of apartment buildings, and property managers are likely to be classified as a small business under any definition cited above.<sup>5</sup> Although additional replacement costs of boilers and heater may affect small businesses and/or homeowners, these costs are disbursed among more than one dwelling unit in multi-unit complexes and over a period of 15 years. As such, the annual impact is expected to be small.

### Employment Impact

Additional assumptions have to be made in order to evaluate the impact of the proposed amendments on the entire four-county economy in terms of employment. The evaluation is performed through a county-based economic model (Regional Economic Models, Inc., 2005) where cost data has to be disaggregated to affected industries at the county level.<sup>6</sup> First, the replacement cost is distributed to the counties of Los Angeles, Orange, Riverside, and San Bernardino according to the number of businesses in each county, using the 2003 County Business Patterns.<sup>7</sup> Within each county, the replacement cost is distributed to only industrial and commercial sectors due to the lack of data on the number of water heaters and boilers in the homeowner market. Single family homes usually have water heaters smaller than those regulated by this rule, although apartment buildings and multi-unit dwellings would use equipment in this size range. The majority of units of this size are used by smaller industrial sites.

Second, the price differential between compliant and noncompliant heaters and boilers will bring additional revenue to the vendor of these units. No specific information is available on sales data, but it was assumed that all Type 1 units would be purchased from wholesalers because the smaller equipment is generally purchased in this manner. It was further assumed that half of Type 2 units would be purchased directly from manufacturers because the larger units may require additional work from the manufacturers. It should be noted that some retail plumbing and hardware stores may also carry boilers and heaters. Finally, the assessment of employment impact on the local economy includes the cost of progress reports only for local manufacturers of Type 1 and Type 2 heaters and boilers.

On average, there would be five jobs created annually from 2008 to 2020 in the four-county economy. The majority of jobs created would go to the wholesale trade industry to which wholesalers of heaters and boilers belong. There are very few impacts on other sectors of the local economy. This is because the cost impact is distributed across all the sectors and the impact on each individual sector is relatively small. The majority of job creation occurs in earlier

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<sup>5</sup> For example, of the 282 establishments in the sector of plumbing and heating equipment and supplies merchant wholesalers in the four-county area according to the 2003 County Business Patterns for California, 185 (66 percent) had fewer than 10 employees.

<sup>6</sup> Regional Economic Models, Inc., Policy Insight: SCAQMD Four-Region 70-Sector Model, Version 7.0.107, 2005.

<sup>7</sup> U.S. Census Bureau, County Business Patterns, California: 2003, September 2005, Washington, D.C. Retrieved from <http://www.census.gov/prod/2005pubs/03cbp/cbp03-6.pdf>, March 10, 2006.

years of the simulation period. Job creation peaks in 2012 (53 jobs created) when all the new units are expected to comply with the lower NO<sub>x</sub> limits. Over time when more units are replaced, cumulative cost impacts from earlier years would begin to offset jobs created in the wholesale sector. Beginning in 2017, the local economy would experience three jobs forgone. This trend is projected to continue after 2017.

## **DRAFT FINDINGS UNDER CALIFORNIA HEALTH & SAFETY CODE SECTION 40727**

California Health and Safety Code Section 40727 requires that prior to adopting, amending or repealing a rule or regulation, the AQMD Governing Board shall make findings of necessity, authority, clarity, consistency, non-duplication, and reference based on relevant information presented at the public hearing and in the staff report. In order to determine compliance with Sections 40727, 40727.2 require a written analysis comparing the proposed amended rule with existing regulations.

The draft findings are as follows:

**Necessity:** A need exists to amend Rule 1146.2 to reduce emission limits for small boilers and large water heaters in order to meet federal and state ambient air quality standards.

**Authority:** The AQMD obtains its authority to adopt, amend, or repeal rules and regulations from California Health and Safety Code Sections 39002, 40000, 40001, 40440, 40440.1, 40702, 40725 through 40728, 41508, and 41700.

**Clarity:** PAR 1146.2 has been written or displayed so that its meaning can be easily understood by the persons affected by the rule.

**Consistency:** PAR 1146.2 is in harmony with, and not in conflict with or contradictory to, existing federal or state statutes, court decisions or federal regulations.

**Non-Duplication:** PAR 1146.2 does not impose the same requirement as any existing state or federal regulation, and is necessary and proper to execute the powers and duties granted to, and imposed upon the AQMD.

**Reference:** In amending this rule, the following statutes which the AQMD hereby implements, interprets or makes specific are referenced: Health and Safety Code sections 39002, 40001, 40702, 40440(a), and 40725 through 40728.5.

## **COMPARATIVE ANALYSIS**

Under Health and Safety Code Section 40727.2, the AQMD is required to perform a comparative written analysis when adopting, amending, or repealing a rule or regulation. The comparative analysis is relative to existing federal requirements, existing or proposed AQMD rules and air



pollution control requirements and guidelines which are applicable to industrial, institutional, and commercial water heaters, boilers, steam generators, and process heaters.

The AQMD staff is not aware of any other AQMD, state or federal requirements regulating air pollution that are applicable to Rule 1146.2-type units. The amendment does make an existing AQMD limit or standard more stringent. However, as there are no other existing air pollution requirements for Rule 1146.2 type units, the proposed amendments are not in conflict with and do not duplicate existing AQMD, state or federal requirements. Since units subject to PAR 1146.2 do not require permits to operate, Best Available Control Technology requirements under the AQMD's New Source Review Program are not applicable.

## **REFERENCES**

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## REFERENCES

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Robert Mowris & Associates, 2004. *Evaluation Measurement and Verification Report for the Local Small Commercial Energy Efficiency & Market Transformation Program #208-02 (Prepared for Southern California Gas Company)*. Robert Mowris & Associates and Energx Controls, June 2004.

SCAQMD, 2004. *Implementation Study for Rule 1146.2 – Emissions of Oxides of Nitrogen from Large Water Heaters and Small Boilers (400,000 to 1,000,000 Btu/hr)*. South Coast Air Quality Management District, June 2004.

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SCAQMD, 1996. *1997 Air Quality Management Plan, Appendix IV-A, Stationary and Mobile Source Control Measures*, South Coast Air Quality Management District, November 1996.

## **APPENDIX A: PAR 1146.2 PUBLIC COMMENTS AND RESPONSES**

## PUBLIC COMMENTS AND RESPONSES

1. **Comment:** The NOx emission limit for small pool heaters should stay at 55 ppm. It would not be cost effective to lower emission limits.

**Response:** While there is no technical reason why small pool heaters cannot meet a lower emission limit, the cost effectiveness is high due to the low usage of such units and is the basis for the emission limit for small pool heaters to remain at 55 ppm.

2. **Comment:** For smaller Type 1 equipment staff's analysis indicates it is more cost effective to meet a 20 ppm limit than a 30 ppm limit. However, industry questions that analysis. There may be other less costly technologies available to meet 30 ppm which will be cost effective. A 30 ppm limit is more palatable and easier to achieve. We encourage staff to propose a 30 ppm (20 ng/J) limit for smaller Type 1 units.

**Response:** Staff is aware that there are other technologies capable of meeting a 30 ppm limit. However, these technologies are not in use by manufacturers supplying boilers and heaters to the AQMD. Some of these technologies have been used to meet the emission limit for smaller Type 1 equipment (55 ppm or 40 ng/J) but are not currently being used to meet the 30 ppm limit of the larger Type 2 units. Staff has requested information on costs for other technologies, but has not received any information to support a cost effectiveness analysis using these other technologies. Nevertheless, under the proposed alternative compliance option, manufacturers will be allowed to sell such units provided their sales weighted average emission level meets the 20 ppm concentration limit.

3. **Comment:** Where do the cost numbers come from and what are the costs? Is this information available to the public? Do you have a flowchart of what you asked for and how it was asked? We question the validity of using that kind of information (survey data). Manufacturers have to look at the cost of taking a piece of equipment from the existing to a new lower emission level. Looking at products that already exist ignores the costs for manufacturers that have not yet met those levels. There are 50 to 60 manufacturers selling products in this size range and many only sell a few products in the AQMD each year.

**Response:** The AQMD staff's analysis is based on the emission reductions achieved and the NOx cost-effectiveness. The cost effectiveness is the cost per pound or per ton of NOx reduced. The AQMD is required to perform such an analysis under state law. The AQMD also prepares a socioeconomic analysis which evaluates the cost of compliance and other impacts on the local economy.

Staff has provided additional information in the Draft Staff Report. Most of the cost information was provided by survey of local suppliers in the AQMD. The information was provided on a confidential basis. Some information was gathered from retailers on the internet. Suppliers were asked to provide a cost for a range of sizes and types of equipment that meet the current limit and identical or similar equipment that meet a lower

limit. Staff used the AQMD Rule 1146.2 certification results to identify equipment that meet different emission levels. In some cases, a unit could meet a lower emission level with minor modifications. In other cases, a different burner and control system would be required. The cost information also includes, where applicable, costs for flue gas recirculation such as piping, a blower and controls.

All manufacturers would have to meet the emission limits and incur similar costs. In some cases, manufacturers have already invested in technology that can meet the proposed limit. As some manufacturers do not currently have equipment that can meet the proposed limits, the proposed rule provides four to six years to redesign products to meet the lower emission limit.

4. **Comment:** It is our understanding that the AQMD is amending Rule 1146.2 in part because of foregone NOx emission resulting from the January 2005 amendment. Many members of the regulated community opposed that amendment as unnecessary and feel that this amendment is also unnecessary. The current proposal should be replaced with an amendment that requires owners of existing units to retrofit Type 2 units in the next few years.

**Response:** This amendment will in part offset the emission reductions forgone due to the January 2005 amendment. However, the primary reason for amending the rule is that the AQMD is not in compliance with the ozone and particulate ambient air quality standards. The proposed amendment will reduce emissions of NOx by approximately 1.8 tons per day. At the January 2005 meeting, the Governing Board of the AQMD made a finding of infeasibility regarding the retrofit requirement for in-use units. Nothing has changed in the last year which would suggest that retrofits are a feasible option for most units.

5. **Comment:** Staff has indicated that most of the product types have examples with emissions less than the proposed limits. This position is problematic because of the following reasons: most of the units under 400,000 Btu/hr are water heaters and not boilers and there is a large variety of equipment. The technology in a tankless (residential instantaneous) water heater is different than the technology in a tank type. The technology that goes into a residential tank type water heater is significantly different than the technology in a commercial tank type water heater. You can't use the residential water heater rule analysis to assess the technology in commercial water heaters. The smaller size combustion chambers in Type 1 units contribute to higher NOx emissions. The technology from product types such as steam boilers and hot water boilers does not transfer to water heaters. The rule should have different limits for each category of equipment. Additional time is needed to determine what the rule limits should be for each category.

**Response:** Staff has evaluated the Rule 1146.2 certification results and data from manufacturers to determine the most cost effective option for reducing emission from the wide variety of equipment subject to the rule. While it may be true that one cannot take a burner and system from one category of equipment and use it in another category of

equipment, the most important issues are transferability of available technology, installation cost and potential emission reductions.

Staff has found examples of equipment from every category that can meet the proposed emission limits. The burners used in this equipment are not the same. However, they do use the same type of technologies to achieve lower emissions (various combinations of premixing, staged combustion, radiant surfaces, flue gas recirculation and more sophisticated control systems). The AQMD certification tests include steam boilers, hot water boilers, instantaneous water heaters and tank type water heaters that achieve the proposed emission limit. While there are no examples of residential size instantaneous water heaters that meet the proposed limits, this type of equipment currently uses an older burner technology that is no longer used by larger equipment that meets the proposed limit. In addition, there are examples of boilers and other types of water heaters in the same heat input range that can meet the proposed 20 ppm limit.

Staff used the residential tank type water heater analysis from AQMD Rule 1121 to estimate the cost effectiveness of the smallest Rule 1146.2 tank type water heaters. These heaters are nearly identical in design to residential units except for the dimensions of the tank and the rating of the burner. Each water heater company sells units with atmospheric burners with ratings between 75,000 to 100,000 Btu/hour and that use a pilot light. These units do not require a supply of electricity and are often installed in residences.

Staff provided additional time for industry to evaluate the initial staff proposal. Since the March 1, 2005 working group meeting with industry staff has conducted additional small group meetings with industry a public workshop and a public consultation meeting. The proposed rule amendment has been modified to incorporate industry concerns by extending the compliances dates and providing an alternative compliance option.

6. **Comment:** While some manufacturers may advertise units with emissions less than 10 ppm, it is only a marketing tool. That equipment cannot run continuously at under 10 or under 20 ppm. They were tested for 30 ppm only. Burner manufacturers need to know the details of how equipment is used before committing to 20 ppm for their burner.

**Response:** Rule 1146.2 requires manufacturers to certify that equipment that meets the emission limits in the rule using a testing procedure that has been approved by the AQMD, CARB and USEPA. Manufacturers do need time to fine tune a burner system in each new application. The proposed rule provides four to six years for boiler and burner manufacturers to comply. Manufacturers typically design their equipment to meet emission limits with some margin of safety. A concentration limit of 20 ppm provides manufacturers that margin.

7. **Comment:** A limit of 20 ppm will result in a loss of fuel efficiency. More natural gas will be consumed. Meeting a concentration limit of 20 ppm will require low efficiency flue gas recirculation (FGR). The technology most often used to meet lower NO<sub>x</sub> limits is lean premix. This lowers peak temperature of the flame and NO<sub>x</sub> levels. However, there is a trade off with efficiency.

**Response:** Staff has evaluated the potential for lower NO<sub>x</sub> limits to result in decreased fuel efficiency. In lowering the NO<sub>x</sub> limit from 55 ppm to 30 ppm or 20 ppm there is typically an increase in combustion efficiency due to better control of the mixing of fuel and combustion air in the burner system. Many of these burners also emit more energy as radiant heat which reduces the amount of heat leaving the boiler through the exhaust.

Increasing excess air is one of several techniques that can be used to lower emissions from 30 ppm to 20 ppm in a specific unit. Increasing the excess air can result in increased fuel use because the exhaust temperature is lowered and the heat exchanger may not capture the same amount of heat. However, other options that do not result in an increase in excess air are available. Manufacturers can redesign the burner, use different materials for the burner, use a different control system or use FGR. There are several types of FGR which do not always result in a loss of fuel efficiency. If a manufacturer does elect to increase the amount of excess air to achieve lower emissions, it can be offset by redesigning the heat exchanger so that there is no loss of efficiency. All boilers and water heaters are required to meet federal and state efficiency standards.

8. **Comment:** Twenty ppm is achievable. The rule is already too complicated. If the rule was differentiated into more categories, it would be even more complicated and difficult to explain to customers.

**Response:** The proposed rule retains the original rule categories and provides time for all manufacturers to meet the proposed limit

9. **Comment:** Are LPG units being exempted now?

**Response:** If a unit is only designed to burn fuel other than natural gas, it is exempt from the rule limit and from the requirement to certify its emissions. If a unit can burn natural gas and any other fuel, it must be certified to meet the emission limit when burning natural gas.

10. **Comment:** Are small instantaneous water heaters subject to the rule?

**Response:** Yes, small instantaneous water heaters are subject to the Rule 1146.2. However, the proposed rule has been modified to clarify the applicability.

11. **Comment:** Since dates are removed from the definitions of Type 1 and 2, is the intent to allow sale of used units only if they meet the current limits?

**Response:** Yes, the proposed rule allows the sale of used units if they meet the rule limit in place at the time of the sale.

12. **Comment:** What happens to units running at 30 ppm now when the limit changes?



**Response:** This proposed amendment does not affect existing in-use units. Units that are currently required to be retrofit to meet the existing emission limit are required to meet 30 ppm.

13. **Comment:** One of the casualties of this rule proposal would be high efficiency units. One would expect half of these types of equipment available would not be available in the AQMD. It will not be cost effective for a manufacturer to change their product for such a limited market. Many of the 90% efficiency and up models will not be available.

**Response:** There are currently examples of both high efficiency boilers and water heaters in a range of sizes meeting the proposed 20 NOx ppm limit. As not all manufacturers currently have products that meet the 20 ppm limit, the proposed rule provides four to six years to develop low NOx products. To address this issue, the rule also provides an opportunity for manufacturers to report on progress in towards meeting the emission limit two years prior to the compliance date. At the time the progress reports are submitted, the AQMD will evaluate the need for a rule amendment. The proposed rule also provides and alternate compliance unit in terms of nanograms per joule of heat output. The AQMD is also committed to working with industry on an alternate compliance plan option which could be added to the rule at a later date.

14. **Comment:** The AQMD needs to include provisions for solar energy in the proposed rule that would allow units with higher NOx emissions to meet the rule limits through increased energy efficiency due to the use of solar power.

**Response:** The AQMD is currently evaluating ways to provide incentives for the use of more efficient equipment.

15. **Comment:** This rule amendment seems misguided. There are more emission reductions available from other sources.

**Response:** Due to its non-attainment status, the AQMD is obliged to implement all feasible measures to reduce emissions from a wide variety of sources in order to meet the ambient air quality standards for ozone and particulates. This proposed rule will reduce emission of NOx by 1.8 tons per day. Staff would welcome suggestions that would result in cost-effective reductions from other sources.

16. **Comment:** It is more difficult to achieve lower NOx emissions with thermal fluid heaters that operate at very high temperatures. The rule should allow a higher limit for thermal fluid heaters.

**Response:** The proposed rule provides manufacturers of thermal fluid heaters the opportunity to submit a progress report two years prior to the compliance dates and request the AQMD to revise the emission limit for thermal fluid heaters.

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